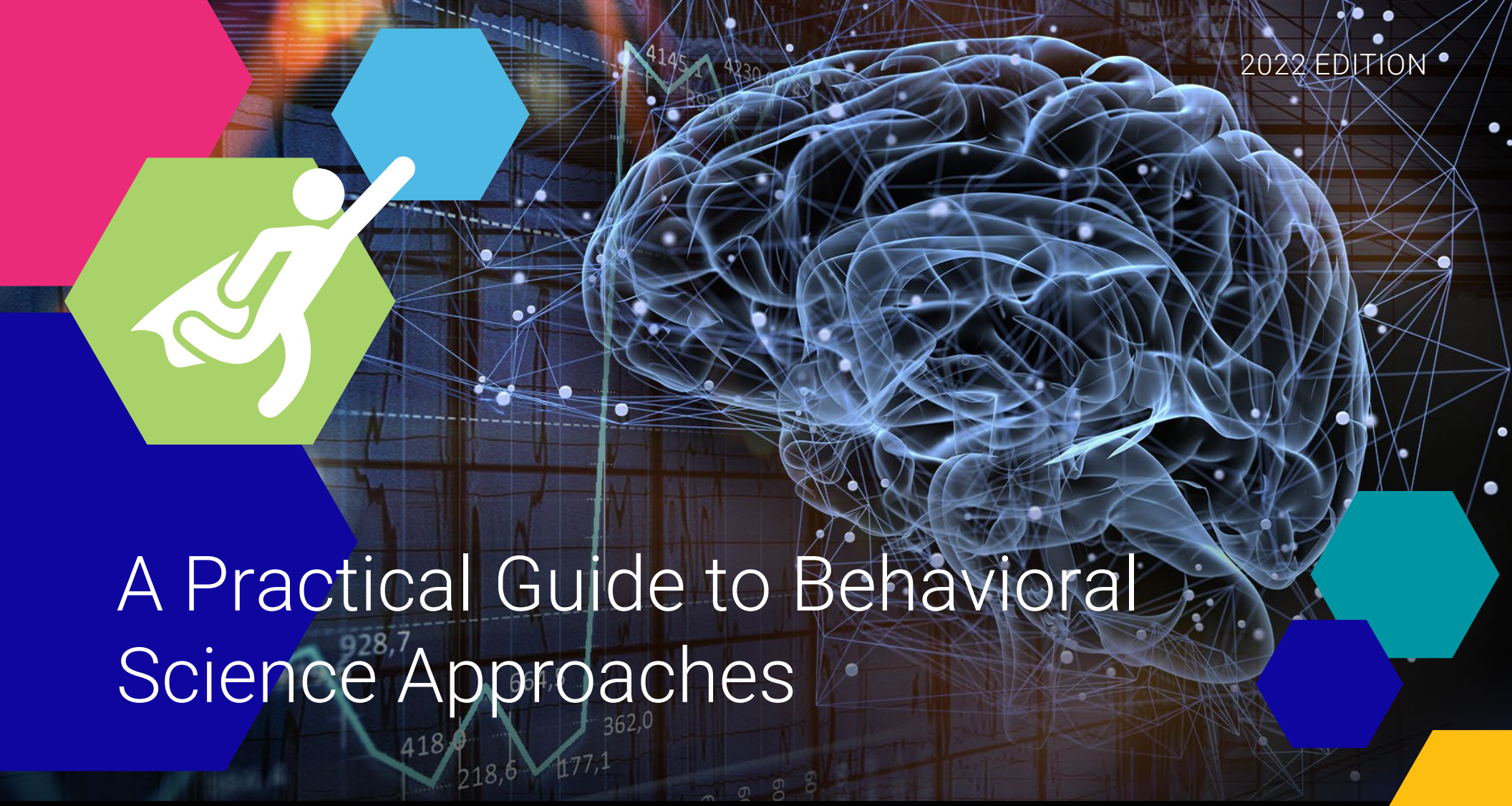

2022 EDITION

A Practical Guide to Behavioral Science Approaches

SENTIENT LABS®

The methods, measures and technology used to improve creative performance.

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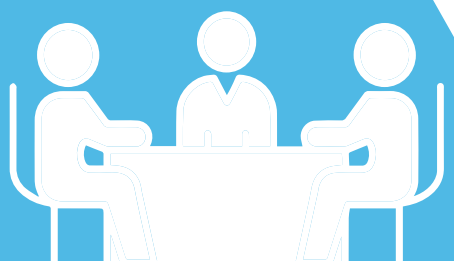
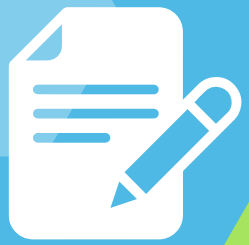




FORWARD

This guide is meant to provide an entry into the behavioral science measures and methods used within market research today. Developed by market researchers and behavioral scientists at Sentient Decision Science to help businesses advance their knowledge of the tools and technology used for best actionable insights.

The specific measures and methods described in this guide are targeting the advanced behavioral science methods and not the traditional behavioral science approaches used like focus groups or standard surveys.

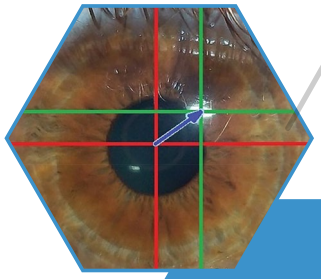
The guide separates measures into two groups to help classify the approaches:

1. Timed Exposure & Response Time-Based Methods
2. 'Bio' and 'Neuro' Methods

Here are some of the questions this guide will help answer:

- What are the definitions and research outputs of these advanced measures?
- What are the pros & cons of the measures used in market research?
- What is the right construct of behavioral science measures to use for innovative and creative phases?

Defining the Elements Within the Spectra

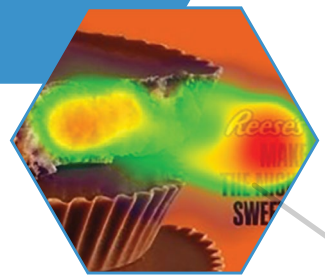


Input: Images placed here are memorable visual representations of the information acquired by a particular method or technology, an image of a relevant technological device, or the context in which data is collected.

ET
Eye Tracking

Identifies whether specific elements of ads, concepts, or packages attract visual attention. Captures Frequency & Duration of Gaze, Focused Attention & Scattered Attention.

Method Key: Each Method is represented by a hexagon of a specific color, containing an abbreviated method title (e.g. "ET") and a concise description. Each method's unique colored hexagon and abbreviation is used to represent that method and make it easy to find across all other images, charts, and text callouts.



Output: A memorable example of the data a particular method or technology might produce, a relevant application area, or the kind of insights or reporting associated with it.

E.g., Eyetracking data in MR is frequently shown as heatmaps, showing what parts of an image most respondents looked at on average over a specified period of time.

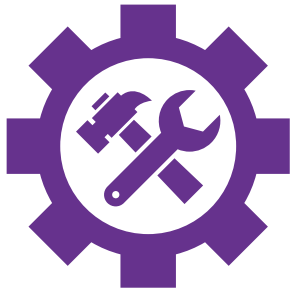
Crawl/Walk/Run/Fly: An indication of the degree to which each method or technology's use in Insights has matured, or the degree to which Insights professionals have become familiar with best practices for maximizing Return on Insights Investment. 'Crawl' indicates that progress with a particular method may be slow-going or less easy to integrate with other research efforts. 'Fly' indicates that a method is ready for rapid application and that vendors with the requisite experience and expertise are able to develop insights using the methods that integrate sensibly into your current knowledge base and business practices.

MEASURES AND METHODS

Behavioral Science includes research disciplines, methods, and technologies ranging from Findability, to Eyetracking, to Psycholinguistics, to 'Neuro' methods like EEG and Biometrics.

Q: "So 'Neuro' methods are part of Behavioral Science? What about 'Cognitive Science' or 'Behavioral Economics'? How do these fit in?"

A: Yes! These all share the same goal: to understand human behavior and the mental processes behind it. Given that the brain is the most complex object in the known universe, the variety of tools and approaches required to understand it isn't surprising!



The methods, measures, and technology available to optimize creative performance:

- **PRIME:** Implicit Priming
- **PoE:** Proportion of Emotion Model
- **IAT:** Implicit Association Testing
- **T-Scope:** Tachistoscope
- **FIND:** Findability
- **ET:** Eye Tracking
- **BIO:** Biometrics
- **EEG:** Electroencephalogram
- **QC:** Quick Conscious Association Testing (Response Latency)
- **FACS:** Automated Emotional Expression Recognition
- **SST:** Steady State Topography
- **fMRI:** Functional Magnetic Resonance Imaging

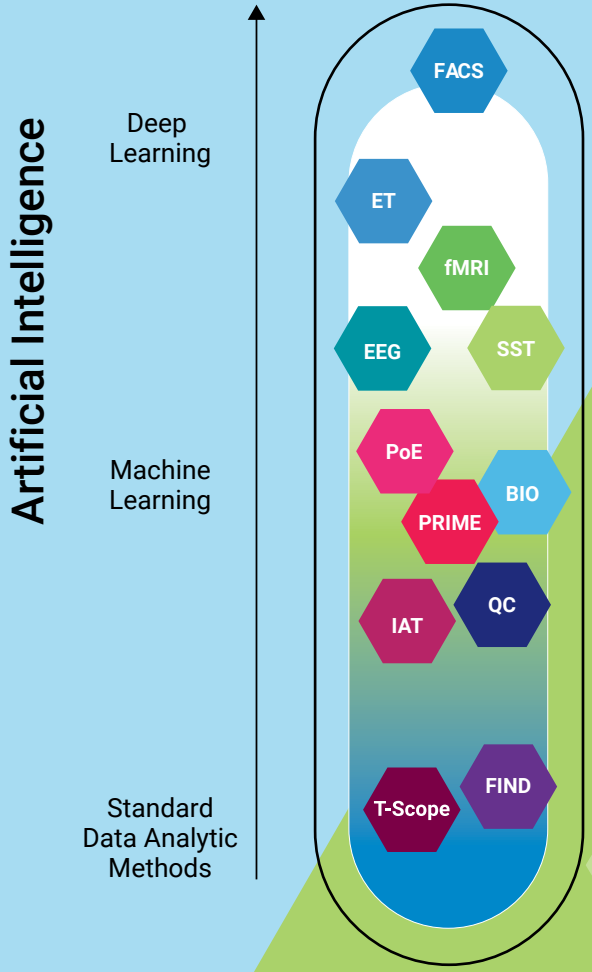
Maturity Level within research industry

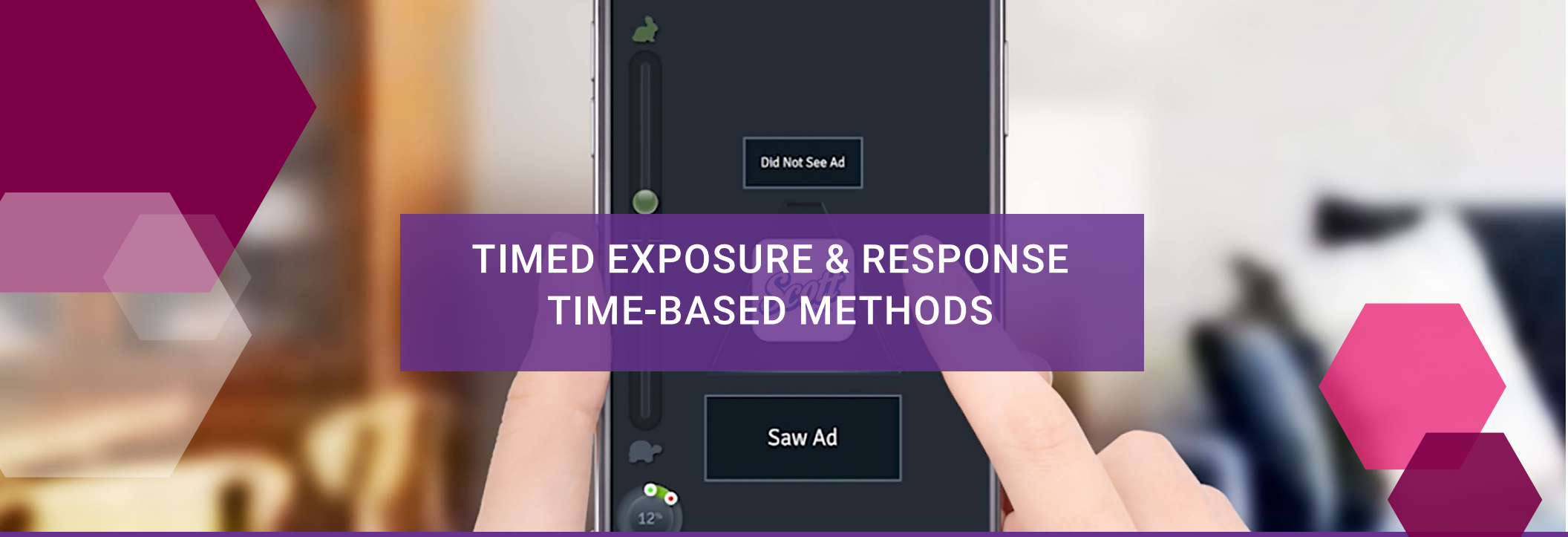
ARTIFICIAL INTELLIGENCE

How does AI factor into the methods?

CAUTION:

AI is only as "Intelligent" as the people who created it, and only "knows" what it has been "taught!" For example, automated emotional expression recognition is among the most advanced challenges in AI. Of many such platforms available, only a few incorporate the extensive information and advanced understanding of emotional expression and behavior required to produce accurate results under real-world conditions.





TIMED EXPOSURE & RESPONSE TIME-BASED METHODS

Many behavioral science methods leverage precision timing as a critical independent or dependent variable. Precise stimulus exposure times may be used to understand how the brain processes stimuli (in Priming Experiments) or to control how much information is available to be processed (in Tachistoscope Experiments). In other cases, important insights are derived from precise measurement of response times, and/or by forcing rapid decision-making by limiting the amount of time available to respond. Both of these techniques are leveraged in the basic experimental design of Priming Experiments, while only the latter is used in e.g. Quick Conscious and IAT.

TIMED EXPOSURE & RESPONSE TIME-BASED METHODS

PRIME

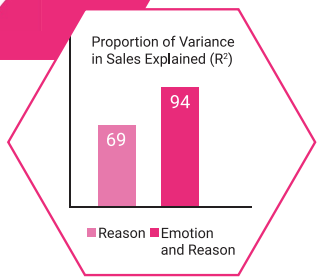
Implicit Priming

Priming is a phenomenon whereby brief exposure to one stimulus (for example: words or images) influences a response to a subsequent stimulus, without conscious guidance or intention.

PoE

Proportion of Emotion Model

PoE is a formal extension of the standard Utility Function model that explicitly integrates System 1 and System 2 measures to produce superior predictions of real-world consumer choice behavior.

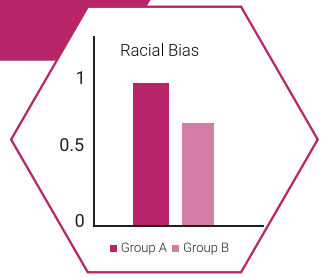


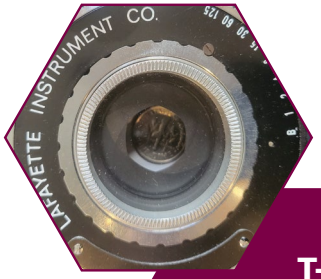
Maturity level within research industry

TIMED EXPOSURE & RESPONSE TIME-BASED METHODS

IAT
Implicit Association Testing

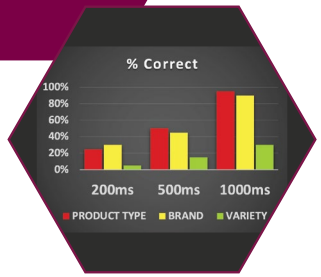
Measurement of non-conscious attitudes and associations focused on “is/is not” compatible to stimuli via response time.





T-Scope
Tachistoscope

An instrument used for exposing objects to the eye for a very brief measured period of time (e.g. how a shelf layout or packaging affects visual attention).

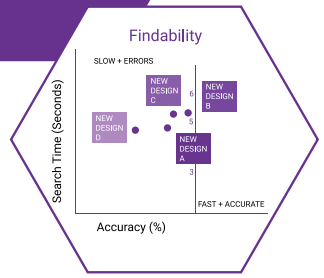


Maturity level within research industry

TIMED EXPOSURE & RESPONSE TIME-BASED METHODS

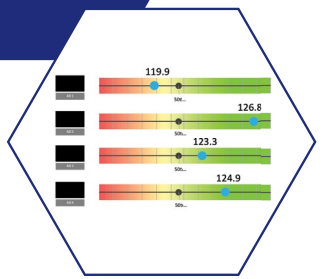
FIND
Findability

Ability for consumer to correctly find and identify product or image among clutter.

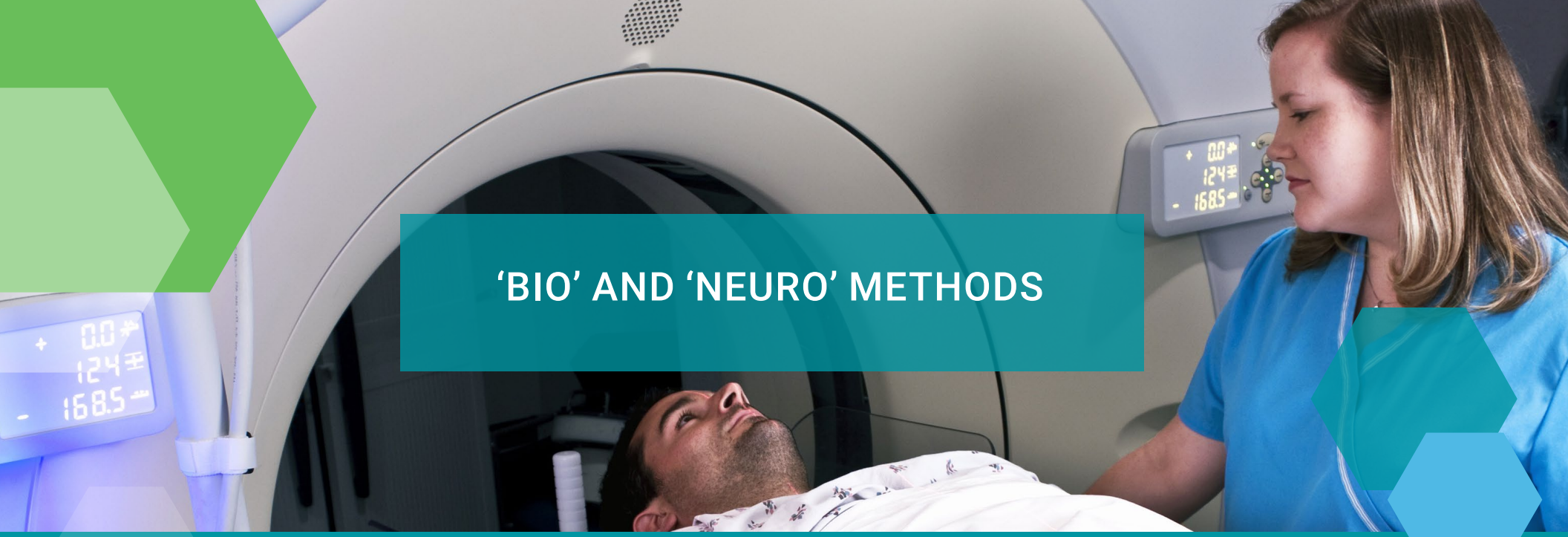


QC
Quick Conscious Association Testing (Response Latency)

Sorting of items into categories according to the individual's personal judgment or preference, often using time pressure to encourage rapid, intuitive decision-making.



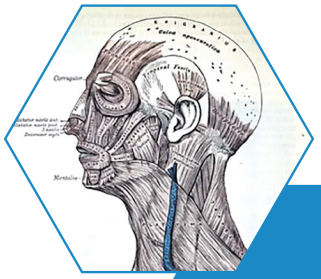
Maturity level within research industry



‘BIO’ AND ‘NEURO’ METHODS

Measures used to reveal heart rate, neural activity, eye movement and facial expressions. These methods collect measures such as heart rate, neural activity, eye movement, and facial expressions. They can record the amount of attention and arousal occurring during exposure to content.

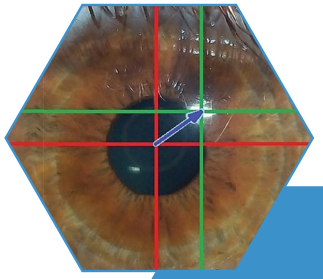
‘BIO’ AND ‘NEURO’ METHODS



FACS

Automated Emotional Expression Recognition

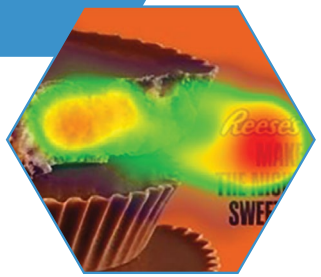
The use of sophisticated computer vision models to track changes in facial expression universally associated with key emotional states.



ET

Eye Tracking

Identifies whether specific elements of ads, concepts, or packages attract visual attention. Captures Frequency & Duration of Gaze, Focused Attention & Scattered Attention.

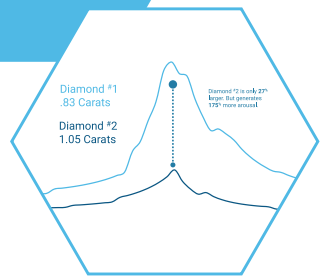


Maturity level within research industry

‘BIO’ AND ‘NEURO’ METHODS

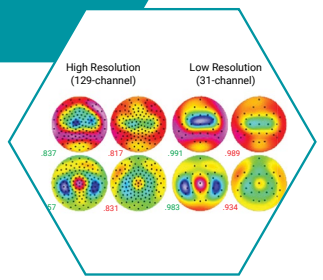
BIO
Biometrics

The analysis of external signals of change in physiological arousal, e.g. skin conductance or heart rate.



EEG
Electroencephalogram

The recording of faint electrical signals from the scalp, from which certain information about brain activity can be derived by various analytic methods.

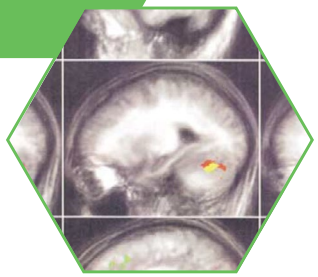


Maturity level within research industry

‘BIO’ AND ‘NEURO’ METHODS

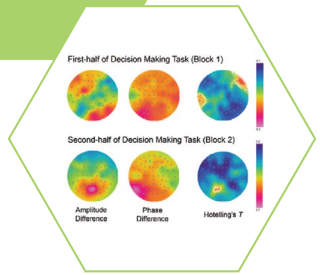
fMRI
Functional Magnetic Resonance Imaging

Uses powerful magnetic fields to precisely visualize activity anywhere in the brain by sensing localized changes in blood flow (the Blood Oxygenation Level Dependent (BOLD) signal).



SST
Steady State Topography

A methodology for observing and measuring human brain activity that involves the use of a EEG to measure electrical brain activity while a participant views audio or visual material.



Maturity level within research industry

BEHAVIORAL SCIENCE SPECTRA

The following information will help provide a practical look at where all the measures and technologies rank among various important paradigms. These spectra will help you understand the degree of predictably or scalability that each measure can provide.

- **PRIME:** Implicit Priming
- **PoE:** Proportion of Emotion Model
- **IAT:** Implicit Association Testing
- **T-Scope:** Tachistoscope
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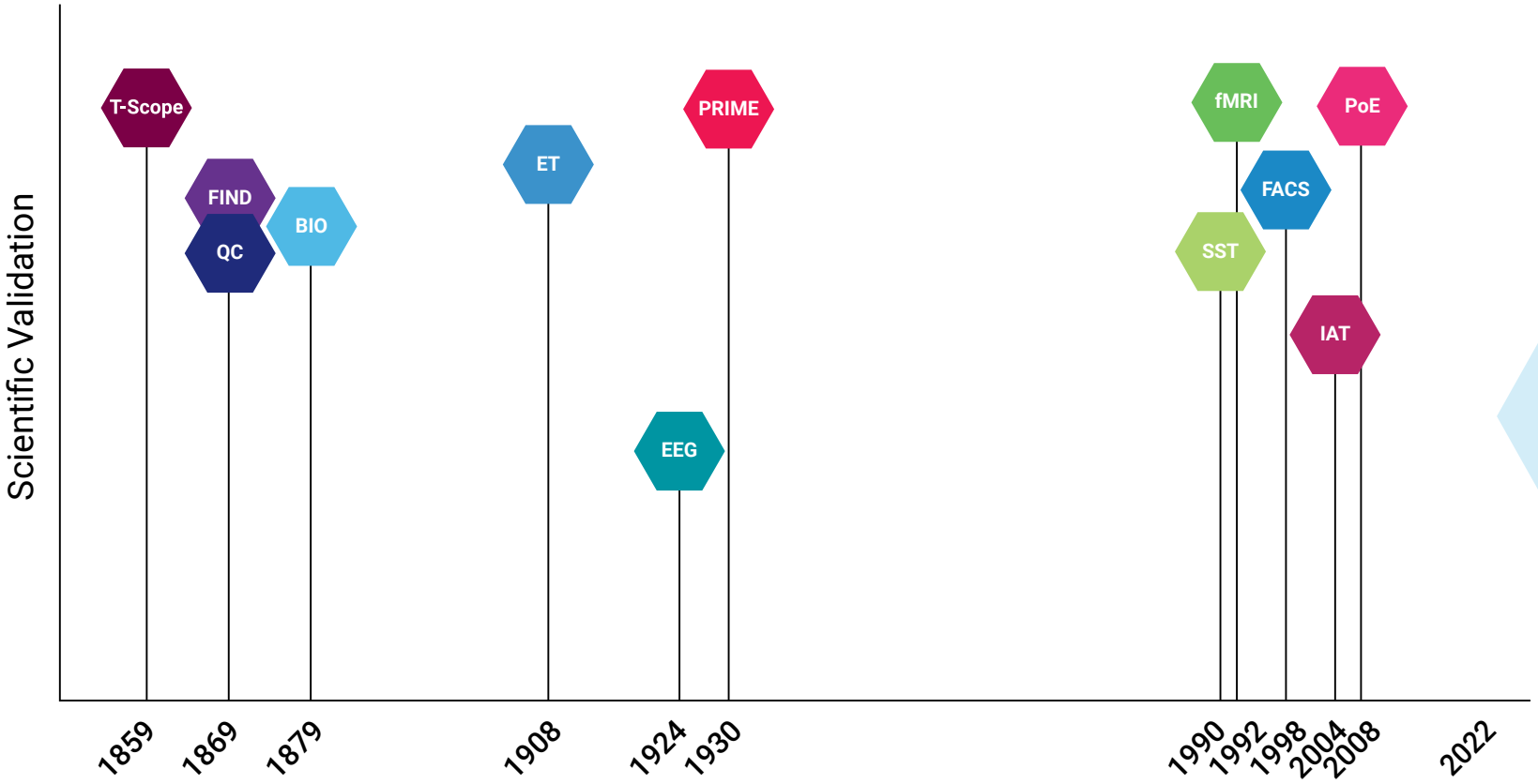
- **EEG:** Electroencephalogram
- **SST:** Steady State Topography
- **fMRI:** Functional Magnetic Resonance Imaging

How long has the method been around, and to what extent has it been scientifically validated?



EEG

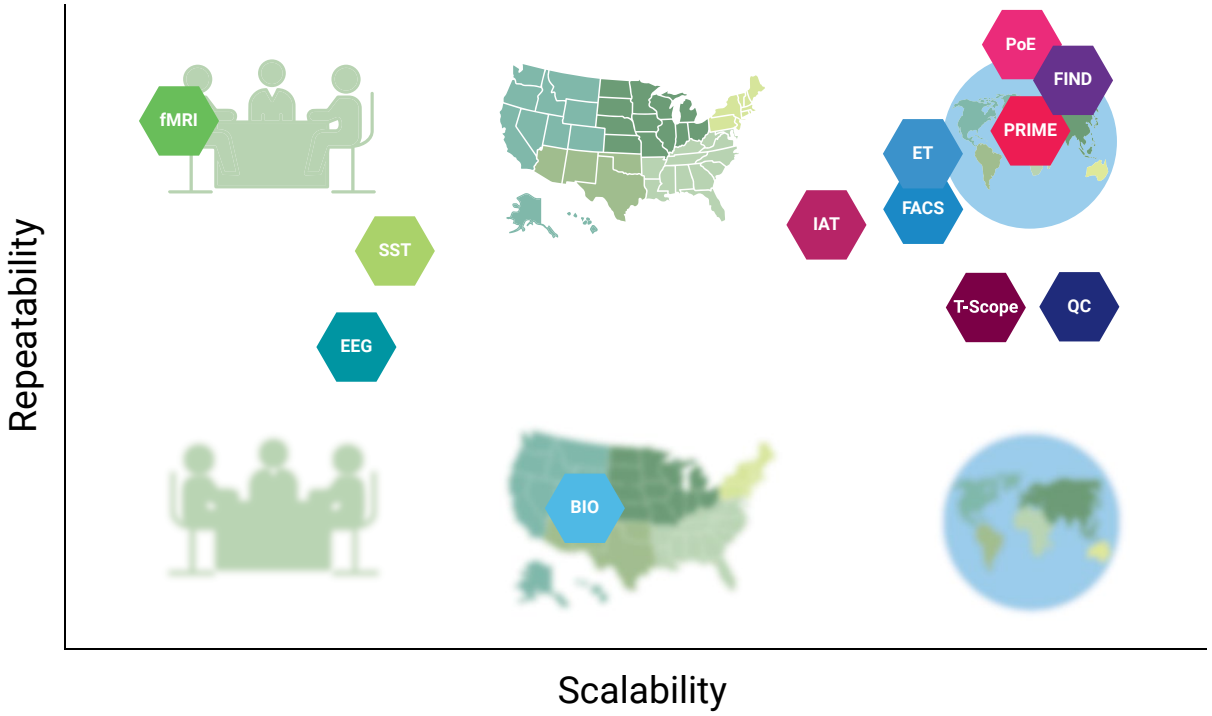
While EEG has been used productively for quite a while, it remains one of the most challenging methodologies, and the meaning of various EEG outputs continues to be hotly debated. Certain EEG outputs are well-understood, but a high degree of expertise is required here.

fMRI

Although fMRI is a relatively new method, our understanding of what fMRI data means with respect to brain activity is well established, and fMRI's ability to record activity anywhere in the brain with high spatial resolution and useful temporal resolution makes fMRI data easily interpretable by neuroscientists with a deep understanding of brain systems and anatomy, relative to cognition and behavior.

How repeatable and scalable are the methods?

The degree to which a method is **scalable** and can produce **accurate** projections of consumer behavior over large, differentiated populations is largely dependent on the ability to apply the method to large, representative samples, and to do so efficiently, remotely, and in the consumer's normal daily context.



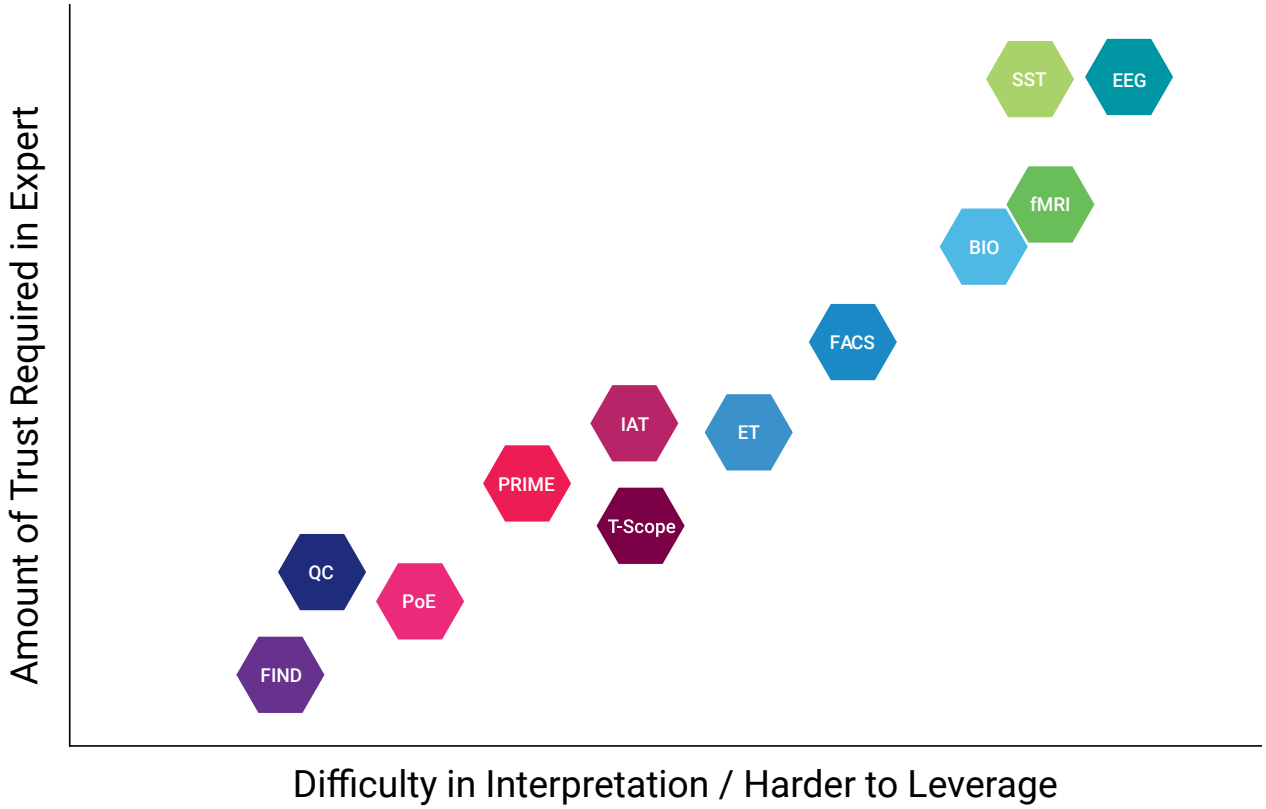
EEG

EEG-based methods have been more widely adopted for use in consumer insights. While these are somewhat more scalable, EEG studies are typically conducted at central facilities and under conditions very unfamiliar to participants. Competent application and interpretation of EEG data requires a very high degree of specialized training, technical expertise, and neuroscientific education, limiting the number of available experts who can deliver on EEG's full potential insights value.

PoE

The Proportion of Emotion (PoE) model is placed in the upper-right quadrant because it combines two highly-scalable methods, Discrete Choice and Implicit Priming, into a model that delivers the highest-available accuracy in predicting real-world consumer choice behavior. This method not only achieves exceptional predictive accuracy, but also produces output that is easily understood and integrated into ongoing business functions, and is rapidly deployable to virtually any consumer population on Earth with access to the internet, while eliminating concerns about regional or cultural response biases.

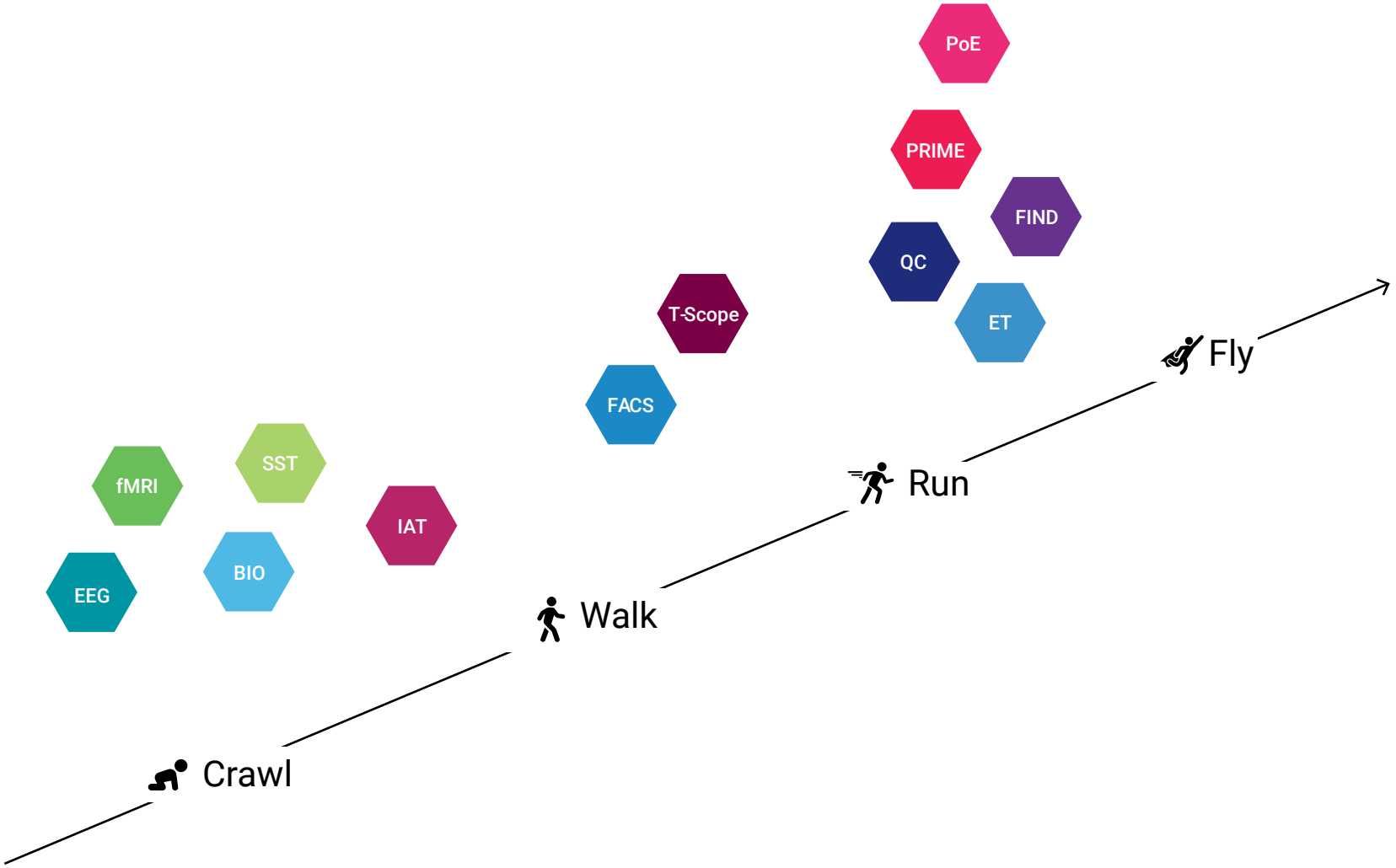
How easy is it to evaluate, interpret, and make flexible, independent use of deliverables?



EEG, SST, Biometrics, and fMRI all require a very high level of specialized expertise in human physiology, cognition, and brain structure and function to apply and interpret effectively. Any organization that does not have personnel qualified to asses the outputs of these methods independently must rely on the expertise and trustworthiness of the individual vendor representative. It is prohibitively difficult to evaluate the quality of insights without advanced internal domain expertise.

Findability is a straightforward behavioral paradigm, and it delivers an easily-understandable output, in familiar language, with clear and direct relevance to business functions familiar across the organization. While specialized expertise is always helpful in leveraging this method most effectively, everyone in the organization can make some practical use of this insight based on intuitive understanding of the data and relevant language, and its clear relevance to ongoing operations.

How mature are the applications of each method/technology?



APPLICATIONS

How Best to Apply These Measures

CREATIVE DEVELOPMENT
PROCESS AND EXECUTION

INNOVATION AND
BRANDING INITIATIVES

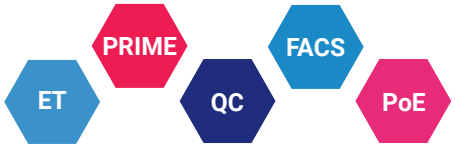
Sentient has provided a high level view of best practices for combining the behavioral science measures at key phases of development to help improve your decision making power. Sentient Insights provides best in class research products that deliver actionable insights at every phase of the creative process including custom research for unique business intelligence initiatives. The products are a result of over a decade of applied science and are specifically designed to improve and predict creative performance.

The following information shows the recommended blend of behavioral science techniques needed at various phases of creative asset development as well as product and marketing innovation that are used for marketing research today.

For more information on the research products and a deeper dive into examples of the results they provide contact info@sentientdecisionscience.com.

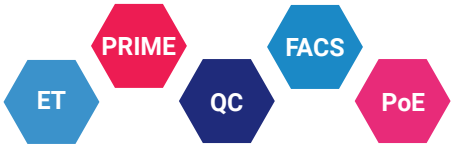
CREATIVE DEVELOPMENT PROCESS AND EXECUTION

IDEA DEVELOPMENT



TV ROUGH CUT

FINISHED MEDIA



PRINT

DIGITAL MEDIA

SOCIAL MEDIA

Subtext®

Subtext was built on a fundamental model of psychological persuasion: Engagement and Influence. Subtext's unique blend of System 1 and System 2 research methods reflects the most up to date knowledge of how the brain processes information and reveals the underlying drivers of emotion in advertising. Subtext equally weights Engagement & Influence to identify specific optimization opportunities and predicts market performance.

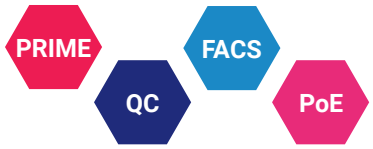
CREATIVE TESTING RECOMMENDATION

3 times during new product development.

- 1 test at storyboard or animatic phase
- 1 test during the rough cut for each :60, :30 or shorter length media
- 1 test to refine the finished media

CREATIVE DEVELOPMENT PROCESS AND EXECUTION

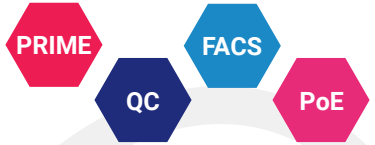
SONIC IDENTITY



SONIC PULSE®

Sonic Pulse isolates and quantifies the true emotional response to radio ads and sounds

RADIO



SONIC PULSE®

Sonic Pulse isolates and quantifies the true emotional response to radio ads and sounds

MEDIA BUY

Subtext®

Subtext analyzes attention, affect, memory and desire to predict and improve ad performance.

TESTING SHOULD VARY BASED ON MEDIA WEIGHT

Testing investments should be proportional to the media buy to mitigate risk.

TESTING IN-MARKET

- Test as often as you're able to make changes.
- Test more frequently with campaigns that have a higher media buy.

INNOVATION AND BRANDING INITIATIVES

BRAND POSITIONING

Narrate®

Narrate identifies & validates an advantaged brand narrative.

CONCEPT

eCON®

eCON applies reason and emotion to deliver a more accurate reflection of behavior towards concepts.

PACKAGE

PULSE®

Pulse uncovers the impact of package design on implicit perceptions, emotions and choice.

IN STORE

PULSE®

Pulse uncovers the impact of package design on implicit perceptions, emotions and choice.

CLAIMS

affirm®

Affirm quantifies the emotional and unexpected impact claims have on your brand.

APPENDIX

The following information provides detailed descriptions on the measures and methods specified within this document.

DEVELOPED BY:

Dr. Aaron Reid & Dr. Cyrus McCandless
Sentient Insights

For more information visit: www.sentientdecisionscience.com

Questions? info@sentientdecisionscience.com

SST Output image*: Examining the Neural Correlates of Choice Behavior in a Gambling Task Using Steady State Topography Article* in ***Journal of Neuroscience Psychology and Economics · May 2010***

fMRI output image: An fMRI Study of the Effect of Amphetamine on Brain Activity *Stephen J. Uftring, Ph.D., Stephen R. Wachtel, Ph.D., David Chu, Ph.D., Cyrus McCandless, B.S., David N. Levin, M.D., Ph.D., and Harriet de Wit, Ph.D.* ***Neuropsychopharmacology 25:925–935, 2001***

Principal Components Analysis of Laplacian Waveforms as a Generic Method for Identifying ERP Generator Patterns: II. Adequacy of Low-Density Estimates. Jurgen Kayser, Craig E. Tenke. ***Clinical Neurophysiology 117 (2006) 369–380***

Emotion as a tradeable quantity; Reid AA, González-Vallejo C, J Behav Decision Making (2008)

PRIME
Implicit Priming

Priming is a phenomenon whereby brief exposure to one stimulus (words or images) influences a response to a subsequent stimulus, without conscious guidance or intention.

PRIME - IMPLICIT PRIMING

Over the course of the 20th century, experimental psychologists, psycholinguists, cognitive scientists, and neuroscientists arrived at an overwhelming consensus: the encoding, storage, and recall of memory, knowledge, and behavioral responses to stimuli is best understood as a continuous network of learned associations, rather than a linear or hierarchical organization of information. While detailed academic questions remain, this model is universally considered to be correct for practical purposes.

In such an 'associative network,' each 'node' represents a concept or other piece of information like a behavioral response, and activation of any node by exposure to a stimulus representing a concept (or blend of concepts) leads to some amount of activation of neighboring nodes or related associations—a phenomenon called *'spreading activation*.' The number, kind, and strength of associations among items in an individual's 'semantic network' varies with experience. *Spreading activation* allows us to predict events and prepare for them, read efficiently by predicting what comes next, drive without effort, and notice when things aren't going as expected and stop to investigate further or modify our expectations or behavior appropriately in real time.

This network of learned information is most reliably studied through the use of *priming experiments*, which combine precisely-timed exposure of information like images or words (i.e. tachistoscopic presentation) with precise measurement of response times on behavioral tasks nominally unrelated to primes presented for specific, brief intervals. Priming experiments, 'perceptual conflict' experiments (e.g. the Stroop Task or IAT), and similar methods measure the 'distance' between related concepts, with varying degrees of 'intrinsic noise' (the error left over after all practical efforts have been made to eliminate 'noise' in the measurement).

In general, three major categories of *priming* are recognized: *semantic, affective, and associative*. **Semantic priming** experiments aim to measure the 'distance' between concepts as represented by words and/or images. **Affective priming** measures the emotional response elicited by a prime, in terms of *magnitude* and/or *valence* and/or specific kinds of emotional responses (e.g. anger vs. disgust). **Associative priming** measures 'pure associations' that have no objective reason to be related other than repeated experience, like the association between 'apples' and 'red,' or 'hamburgers' and McDonald's. In practice, the category to which specific experiments belong can be difficult to determine, since e.g. emotion words may be associated with other stimuli due to repeated exposure (e.g. "Love" and McDonald's' tagline "Lovin' it") or because of a basic affective (emotional) response (e.g. "Love" and an image of a loved one).

Brief exposure to a *prime* activates the network of concepts related to it. What's measured is the degree to which exposure to a *prime* and the activation of associated concepts *interferes* with or *facilitates* performance on behavioral tasks involving potentially-related concepts. The result is a measure of association between the prime and concepts represented in the behavioral task. Data from such experiments, while 'noisy' at the individual level, are considered the best-available metric of learned associations among concepts, behaviors, etc. in populations. Data from priming experiments led directly to the first useful Natural Language Processing models, including now-familiar voice assistants like Siri and Alexa, and many other breakthroughs in knowledge representation at the heart of modern Artificial Intelligence.

PoE

Proportion of Emotion Model

PoE is a formal extension of the standard Utility Function model that explicitly integrates System 1 and System 2 measures to produce superior predictions of real-world consumer choice behavior.

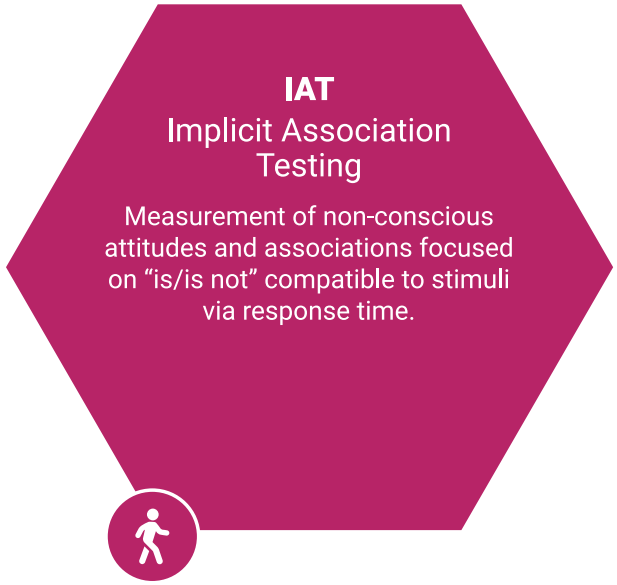
PoE - PROPORTION OF EMOTION MODEL

The Proportion of Emotion (PoE) model is an explicit mathematical integration of emotional response data into the Utility Function of standard economic theory and central to Discrete Choice Modeling. The standard Utility Function partitions the perceived value of a product or service into the value of the component parts that contribute to it (e.g. the number of cylinders in a car's engine, its body style, price, color, etc.), plus some constant ('C') representing any unaccounted-for variance in the prediction of real-world behavior.

PoE adds to this model coefficients representing the magnitude and/or valence of emotional response to each of the component parts of a product or service, and this augmented Utility Function accounts for the emotional component of decision-making behavior (e.g. what product components are most likely to be attended and to factored into decisions). Thus, PoE accounts for both the rational (System 2) and emotional or intuitive (System 1) drivers of real-world decision-making recognized by Behavioral Economics and Neuroeconomics as critical to predicting and explaining human behavior accurately.

By adding emotional responsiveness to the standard Utility Function, PoE reduces the typical error seen in Discrete Choice experiments (accounted for by the constant error term, 'C') by approximately half, producing a result that is far more predictive of real-world purchase behavior than rationally-focused Discrete Choice methods can achieve in isolation.

PoE was originally developed using biometric data (galvanic skin response, which offers a reliable measure of the magnitude but not the valence or specific meaning of emotional responses). Since then, the use of affective priming experiments (PRIME) in place of biometrics has allowed the integration of more granular, context-appropriate measures of valence, further improving the accuracy of predictions of real-world consumer behavior.



IAT - IMPLICIT ASSOCIATION TESTING

Measures subconscious attitudes and beliefs by asking respondents to correctly identify different kinds of items (e.g. images and words) as belonging to one of four different categories (e.g. Black, White, Good, Bad), to understand whether sorting performance is better or worse when any pair of categories requires the same response (e.g. one key is pressed for Black Faces OR Good Words, and a different key is pressed for White Faces OR Bad Words). The IAT requires multiple rearrangements of the categories and response requirements across many trials (e.g. White+Bad/ Black+Bad and White+Bad/Black+Good)--testing a single implicit bias or implicit association with IAT is therefore time-intensive.

Analyzing response times tells us which pairing of categories made it easiest to respond quickly and correctly, indicating how closely associated each stimulus-category pair is in the respondent’s mind. E.g. if Black Faces and Bad Words are easiest to identify quickly and correctly when they share the same response key, and the task becomes measurably more difficult when the same key must be pressed for both Black Faces and Good Words, this indicates a subconscious negative bias toward Black Faces, or that Black Faces and Bad Words are more ‘cognitively compatible’ with one another. In addition to the famous application of IAT to measuring racial bias, IAT can be used to measure the relatedness of semantic concepts, and simple associations among visual stimuli.

CAUTION: Despite what you may have heard from the popular press and books, IAT data is not reliable at the individual respondent level. Over a representative sample, group-level IAT data can be very sensitive and reliable. However, the reliability and usefulness of IAT data is highly dependent on design parameters such as the visual and textual stimuli chosen, as well as expert research design with respect to both the IAT and the context in which it is encountered. Likewise, the *meaning* of an IAT result depends on proper consideration of many design parameters--a clear explanation of what summary labels like “bias” mean in the context of each specific test design is an essential deliverable.

T-Scope
Tachistoscope

An instrument used for exposing objects to the eye for a very brief measured period of time (e.g. how a shelf layout or packaging affects visual attention).

T-SCOPE - TACHISTOSCOPE

The Tachistoscope is the first and perhaps most important invention that allowed precise, quantitative analysis of the fundamental building blocks of perception and cognition. Among other things, the 'T-Scope' led to understanding how we perceive motion in sequences of images, and the invention of high-speed camera shutters and the modern motion-picture.

Knowledge gained from T-Scope experiments led to a huge variety of fundamental discoveries about mental processes and brain structure. The T-Scope is such a simple-yet-powerful tool that it continues to be used widely throughout the behavioral sciences and contribute to new discoveries, including insights into how brain injuries and neurosurgical procedures alter perception and information processing (e.g. in 'split-brain' patients, who've had their brain hemispheres separated to stop life-threatening grand mal seizures), and mapping newly-discovered brain circuits connected to the visual system. Likewise, analogues of the T-Scope are powerful tools for research into auditory, somatosensory, and other brain functions critical to our understanding of consumer experience and behavior.

Importantly, T-Scope experiments are best-suited to understanding "bottom-up" visual attention and cognition, i.e. identifying the information communicated at-a-glance vs. information that can only be absorbed after extended viewing. On the other hand, questions about "top-down" visual attention processes (e.g. intentionally searching for a desired product by looking for something that matches one's internal 'mental model' of that product) are better served by methods like Findability, while eyetracking can reveal important aspects of bottom-up and/or top-down attention, depending on experimental design.

FIND - FINDABILITY

Findability exercises typically answer a simple question about visual assets: How easy or difficult is it to correctly identify or locate a specific object, product SKU, brand logo, image, etc. under various conditions? As with other methods here, findability exercises have many other uses, including in research on reading, intelligence, etc., and can be applied to parallel MR insight needs like communication effectiveness, instructional materials, etc.

While eyetracking and T-Scope experiments can provide useful insight regarding 'bottom-up' attention capture and 'top-down' attention processes relevant to many insight needs, Findability offers more focused insight in behavioral contexts where 'top-down' attention is key.

Two key outputs of Findability are:

1. *What percentage of respondents correctly located/identified the target on the 1st, 2nd, etc. attempt?*
2. *How much time was required to correctly identify/locate the target?*

Quantitative data on the timing and accuracy of search behavior can be leveraged to answer many important questions related to item or SKU-level, e.g. What is the effect of new package designs on brand recognition? What is the effect of new package designs on consumers' ability to distinguish among SKUs or recognize a desired SKU? Which new design supports fluent category orientation and navigation at POP, helping consumers find what they're looking for? Is there a risk that a new design might cause the product/brand to be overlooked at the point-of-purchase? Which design captures attention or 'pops-out' best in a crowded environment, whether in-store, online, in print, or outdoors?

How does the package or product design affect navigation and attention capture when placed on the shelf as single or multiple facings, alongside other brands, from 3 feet away or at a distance? How effective are design strategies that seek to leverage quirks of visual cognition, e.g. fusion or amodal completion, where multiple packages may work together to be seen as a single, larger object or more attention-grabbing visual feature from a distance?

QC
Quick Conscious Association Testing (Response Latency)

Sorting of items into categories according to the individual's personal judgment or preference, often using time pressure to encourage rapid, intuitive decision-making.

QC - QUICK CONSCIOUS ASSOCATION TESTING (RESPONSE LATENCY)

Often called 'fast explicit' or [misleadingly] "Implicit Response Time (IRT), "Quick-Conscious methods do not measure true implicit biases or associations, but they do offer meaningful improvements in data quality and time-efficiency compared with typical Likert-scale question types. Respondents are asked to decide which of two categories a 'target' image or word belongs to (e.g. Agree/Disagree, Yes/No, or [Brand]/Not [Brand]). They're asked to make these decisions quickly, and to make the same judgment multiple times for each target item.

The speed and consistency of judgments are analyzed to produce fine-grained data that reflects the ease with which judgments are made about each target item, or the 'certainty' and of that judgment. Such 'fast explicit' judgments are not necessarily free of strong conscious influences, so they cannot be said to reflect true implicit attitudes or associations.

However, the requirement that each judgment be made as quickly as possible can reduce the influence of conscious processing, resulting in a measure that more closely reflects the 'intuitive' or heuristic decision-making processes that guide moment-to-moment real-world behaviors. QC is less susceptible to the large conscious influences that dominate Likert scale responses, where respondents tend to take significantly more time to consider how a single response might reflect on them, how they might offend or flatter the researcher or brand, or what message their response might send to the brand.

Wherever it's imperative to understand what consumers either can't articulate or just won't say about a brand, product, or piece of creative, only true implicit measures can provide a reliable read or 'honest answer.' But when there is no strong reason to suspect that respondents can't or won't tell you how they really feel, QC offers better efficiency, more straightforward interpretation, reduced scale bias, and greater reliability and sensitivity than Likert-type questions.

FACS

Automated Emotional Expression Recognition

The use of sophisticated computer vision models to track changes in facial expression universally associated with a small number of key emotional states.

FACS - AUTOMATED EMOTIONAL EXPRESSION RECOGNITION

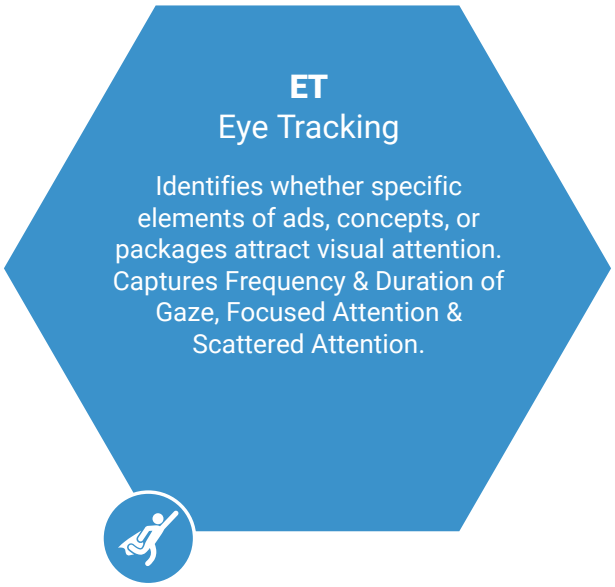
Passive collection of facial expressions, using rigorously-designed AI, provides insight into real-time emotional response to media, in participants' natural context. Human faces are uniquely adapted for non-verbal communication. The 43 muscles of the face generate an enormous variety of expressions that may communicate emotional state or response to a stimulus, and other movements associated with breathing, eating, etc.

The Facial Action Coding System (FACS) was developed by Dr. Paul Ekman and colleagues over decades of quantitative research into emotional behavior, communication, cultural norms, and physiology of people all over the world. FACS is rigorous and exhaustive, accounting for every possible change in facial appearance produced by individual muscles or combinations of muscles, as well as adverse coding conditions such as head motion, lighting conditions, chewing, talking, and poor viewing angles.

A small number of expressions are reliably correlated with basic emotional states. Some 'universal' expressions, such as Happiness, Anger, and Disgust, are useful for communicating important information without shared language. Even when these universal expressions are modulated by social context, they reappear in the presence of trusted friends, or when watching a movie alone.

Specific combinations of facial actions, recorded by trained FACS coders, are much more accurate than untrained observers at identifying specific emotional states, regardless of cultural norms and customs, gender, education, race, etc.

For example, smiling using only the mouth does not correspond to the felt experience of happiness, but when certain muscles around the eyes and cheeks are activated simultaneously with the expected mouth movements, this combination is associated with genuine feelings of happiness and related outcomes, including pro-social and consumptive behaviors like reciprocity, attachment, and goal-seeking.



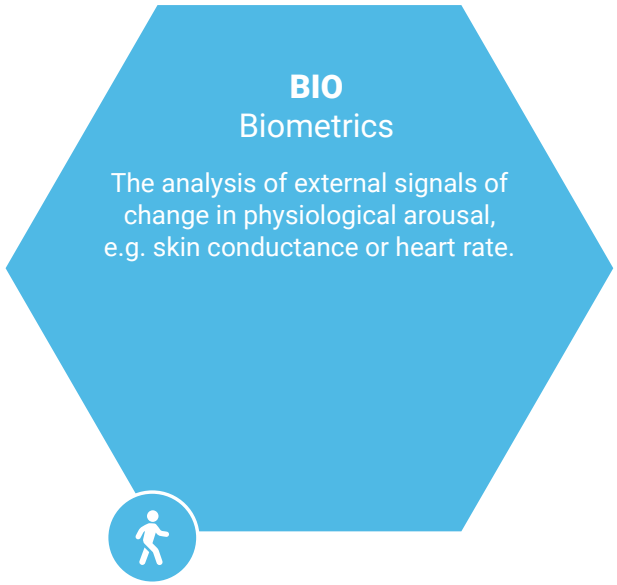
ET - EYE TRACKING

Eye Tracking is a remarkably flexible and useful technology, and is widely used across the behavioral sciences. Eye Tracking technologies vary widely in terms of the accuracy with which they can track eye movements, or gaze, and their temporal resolution (i.e. how many times per second they can provide accurate data on eye position and movement). For some purposes, like understanding how pilots maintain their sense of spatial orientation in extreme situations or studying how children learn to read, extremely high spatial and temporal resolution are required, and these can only be achieved with high-performance laboratory-grade equipment.For many practical applications, like understanding how marketing communications are viewed by representative samples of consumers, a few recently-developed computer vision platforms can record gaze behavior at scale with sufficient accuracy and speed, using respondents' webcams. When studying in-store shopping behavior, specialized wearable eye Tracking systems, with varying degrees of available precision, may be used.

Eye Tracking studies for marketing research typically seek to answer these key questions:

1. *What draws initial attention?*
2. *How do viewers consume the information that they attend to?*
3. *What is and isn't seen after continued exposure?*
4. *For video stimuli, how much attention is paid to the video at any moment in time?*

Aggregated Eye Tracking data may be reported in the form of heatmaps, which provide information about where the average respondent's attention is focused at any moment in time while watching a video ad, or over the duration of exposure to a static image. Respondent-level gaze data, presented in the form of dotmaps, may be useful when studying e.g. packaging or printed copy. In most cases, this data is supplemented by information about aggregated 'gaze fixations' on specific image features, or bits of copy such as callouts and claims, or critical moments in a narrative, that a piece of creative is intended to draw attention to, called Areas of Interest, or AOIs.



BIO - BIOMETRICS

The term “biometrics” refers to a broad range of methods and techniques related to measurement of biological characteristics and physiological signals, from measurements of finger length, to facial recognition, to EEG. However, in the context of behavioral science, this term usually refers to the measurement & analysis of physiological signals indicating [change in] the degree of physical, cognitive, or emotional arousal, including heart rate, respiration, various measures of electrodermal activity (e.g. skin conductance), and pupillometry (measurement of pupil dilation). These indicators of arousal are often referred to as measures of “engagement.” Significant training and expertise is required to obtain valid data from most Biometric measurement devices/techniques, including proper handling, placement, and calibration of sensitive equipment, and knowledge of the conditions under which a given device can produce accurate, reliable readings.

In the absence of strenuous physical activity or basic physiological functions such as eating or sleeping, most biometric methods provide similar information, but with different degrees of sensitivity, temporal resolution, or suitability for different testing environments/conditions. Biometrics can provide high-quality data regarding arousal, but give no unambiguous indication of valence, although this can often be inferred from context. While basic reading and interpretation of biometric data does not require a high degree of expertise, it can be difficult to appropriately limit one’s interpretation to what is actually available from the data.

That is, it can be difficult to avoid interpreting ‘higher arousal’ as ‘positive’ and ‘lower arousal’ as ‘negative.’ While competent analysis of the primary features of biometric datasets can be quite valuable, expertise can make a significant difference in getting the most from them-- a number of important ‘emergent’ characteristics and patterns may appear either within or across biometric datasets which, if recognized and properly interpreted, can provide far more valuable insight than simple analysis of average moment-to-moment changes in levels of arousal during exposure to media.

EEG
Electroencephalogram

The recording of faint electrical signals from the scalp, from which certain information about brain activity can be derived by various analytic methods.

EEG - ELECTROENCEPHALOGRAM

An Electroencephalogram is a recording of electrical signals produced by the brain, as seen by electrodes placed on the scalp (or occasionally on the surface of the brain itself, during surgery). Several different EEG methods and technologies are in common use, with a variety of differences in hardware, methodologies, processing techniques, and applications. Because the electrical activity of the brain is being recorded from some distance, with a significant amount of insulation (skin, bone, etc.) in-between the electrodes and the brain tissue, EEG equipment is extremely sensitive to radiofrequency and electromagnetic noise. For this and other reasons, almost all EEG methods benefit greatly from the use of larger numbers of electrodes (>64). Useful data, limited to a narrowly-defined set of brain functions and related questions, can be had from as few as 20 electrodes in combination with advanced dedicated software and hardware, although robust solutions of this type are not widely available.

While great progress in EEG hardware and software has been made in recent years, obtaining usable EEG data is labor-and time-intensive, and requires significant training regardless of how 'easy to use' any particular equipment is advertised as being; competent EEG data analysis, and the development of useful insights from it, requires a very high degree of expertise, including a comprehensive understanding of the devices used, and the data collection practices and post- processing steps applied to a given dataset.

The origins of many EEG signals, and precisely what they tell us about underlying brain activity related to complex cognitive and emotional functions, remain only partially understood after many decades of intensive study. As such, the interpretation of EEG data is an experts-only affair. While robust insights can be had from proper understanding and interpretation of 'basic' aspects of brain activity (e.g. the presence of visual processing, the encoding or retrieval of memories, or the overall level of cognitive engagement at a particular moment) may lead to powerful and detailed implications related to a business question, the level of detail regarding the specific contents of mental activity is in fact quite limited--EEG is not able to 'see' the brain activity associated with recognizing a familiar face, or say anything about the specific associations spontaneously triggered when a respondent sees or hears the word "red," or sees a brand logo.

Many fundamental questions about the nature of EEG signals remain unanswered, and many disagreements remain. Compared with other neuroscientific disciplines, many confidently-defended theories and ambitiously- specific interpretations of the meaning and significance of EEG signals have gained wide support before being overturned or abandoned over relatively short periods of time.

SST
Steady State Topography

A methodology for observing and measuring human brain activity that involves the use of a EEG to measure electrical brain activity while a participant views audio or visual material.

SST - STEADY STATE TOPOGRAPHY

Some newer applications, such as Steady State Topography (SST), leverage EEG produce more tractable data than others. Using small lights attached to each side of the head (positioned to be visible in peripheral vision) and 'flickering' at a specific frequency, researchers can intentionally induce regular, periodic or 'wave-like' electrical activity across much of the cortex of the brain at a specific frequency. This is known as a steady-state visually evoked potential (SSVEP). This regular, entrained 'standing wave' of brain activity can be maintained indefinitely by the flickering-light stimulus.

As respondents consume media or complete tasks, areas of the brain engaged by the media or activity become less responsive to the flickering-light stimulus. Brain regions engaged by the media or task can then be identified by localized changes in their EEG activity relative to the steady-state 'background' of the SSVEP, which continues in parts of the brain not engaged by the media or task.

Ingenious applications of EEG signals and tools such as SST can offer more straight- forward and reliable data on the engagement of specific brain areas and functions--unlike other EEG-based techniques, there is broad agreement regarding what SST tells us about underlying brain activity, particularly *where* task-related brain activity is occurring. Still, substantial cognitive-neuroscientific expertise is required to make useful sense of this data.

fMRI
Functional Magnetic Resonance Imaging

Uses powerful magnetic fields to precisely visualize activity anywhere in the brain by sensing localized changes in blood flow (the Blood Oxygenation Level Dependent (BOLD) signal).

FMRI - FUNCTIONAL MAGNETIC RESONANCE IMAGING

Functional Magnetic Resonance Imaging uses extremely powerful magnetic fields to visualize activity virtually anywhere in the brain, with superior spatial resolution. Because it requires large amounts of electricity and superconductors cooled to hundreds of degrees below zero, fMRI is capital intensive, hazardous, and not meaningfully portable or scalable.

fMRI detects brain activity over ~0.5 seconds or more; its temporal resolution is poor compared to EEG or SST. However, the latter methods can only reliably detect activity in brain areas near the surface of the head, and aren't well-suited to accurate measurements of activity in other areas, including important portions of cortex that are downward-facing or hidden in deep folds. Like muscles, neurons have direct control over local blood flow to accommodate their changing metabolic needs from moment to moment. Changes in blood flow are recorded as the "Blood-Oxygenation-Level-Dependent" (BOLD) signal: a well-understood measure of local changes in brain activity. If we're exposed to a stimulus that activates specific parts of our visual cortex, or if an image of a product sparks motivation to approach or purchase (indicated most reliably by activity in the Nucleus Accumbens, located deep in the brain and beyond the reach of EEG or SST), fMRI can reliably identify this activity.

However, while fMRI offers the most detailed view of brain activity available, many important cognitive functions arise from sparse, distributed networks of neurons. Only large-scale brain activity (representing macro-level cognitive functions) can be detected with current non-invasive imaging techniques.

Experimental behavioral methods remain the gold standard for measuring and understanding the specific, detailed content and dynamics of everyday cognition, emotion, and decision-making, and are the basis for our understanding of brain imaging data. For example, while fMRI or SST can indicate activity in brain regions responsible for the encoding and retrieval of memories, only behavioral methods can identify the specific information committed to or retrieved from memory, or measure how robustly that information was encoded, or how it impacts other thoughts and behaviors.

A Practical Guide to Behavioral Science Approaches

Produced by Sentient Decision Science.
Published December 2021.

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